

Bannock Russet: A Dual-Purpose, Russet Potato Cultivar With High U. S. No. 1 Yield and Multiple Disease Resistances

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ABSTRACT

Bannock Russet, a late-maturing, long russet potato cultivar, was released in 1999 by the USDA-ARS and the experiment stations of Idaho, Oregon, and Washington. It is suitable for processing into french fries and other frozen products. Its attractive russeted skin and excellent culinary qualities also make it suitable for fresh market. Bannock Russet, in comparisons with Russet Burbank, has consistently produced greater U.S. No. 1 yields in trials conducted throughout southern Idaho. In other western trial sites, total yields of Bannock Russet have been comparable to or smaller than that of Russet Burbank, but its percentage of undersize and cull potatoes is consistently less. Bannock Russet is resistant to potato virus Y (PVY), Verticillium wilt, common scab, and leafroll net necrosis. It also has moderate resistance to early blight (foliar and tuber) and *Erwinia* soft rot. With respect to other potato diseases/disorders, Bannock Russet's level of susceptibility is similar to that of Russet Burbank; the exception being shatter bruise, with Bannock Russet displaying a greater susceptibility. Cultural management guidelines have been developed to minimize shatter bruise in Bannock Russet. Bannock Russet's multiple disease resistances coupled with its low nitrogen requirement, make it a low-input cultivar that could significantly reduce growers' production costs.

RESUMEN

Bannock Russet, un cultivar de papa de maduración tardía, alargado y rojizo, fue liberado en 1999 por USDA-ARS y las estaciones experimentales de Idaho, Oregón y Washington. Es adecuado para el procesamiento de papas fritas a la francesa y otros productos congelados. Su atractiva piel rojiza y sus excelentes cualidades culinarias lo hacen igualmente adecuado para el mercado fresco. En los ensayos realizados en todo el sur de Idaho, en comparación con Russet Burbank, la variedad Bannock Russet sistemáticamente ha obtenido el primer lugar en rendimiento de los Estados Unidos. En otros campos de prueba del oeste, los rendimientos totales de Bannock Russet han sido equivalentes o más bajos que los de Russet Burbank, pero el porcentaje de papas con tamaño insuficiente y de desecho es notablemente menor. Bannock Russet es resistente al virus Y de la papa (PVY), a la verticilosis, sarna común y a la necrosis reticulada de enrollamiento de la papa. También posee resistencia moderada al tizón temprano (foliar y tubérculo) y a la pudrición blanda por *Erwinia*. Respecto a otras enfermedades o trastornos de la papa, el nivel de susceptibilidad es similar al de Russet Burbank, con excepción de que Bannock Russet es más proclive a que se produzcan magulladuras con rotura de la piel del tubérculo. Las pautas de manejo cultural han sido desarrolladas para reducir al mínimo dichas magulladuras en Bannock Russet. La múltiple resistencia a enfermedades de este cultivar se aúna a su bajo requerimiento de nitrógeno, que convierte a Bannock Russet en un cultivar de baja inversión que puede

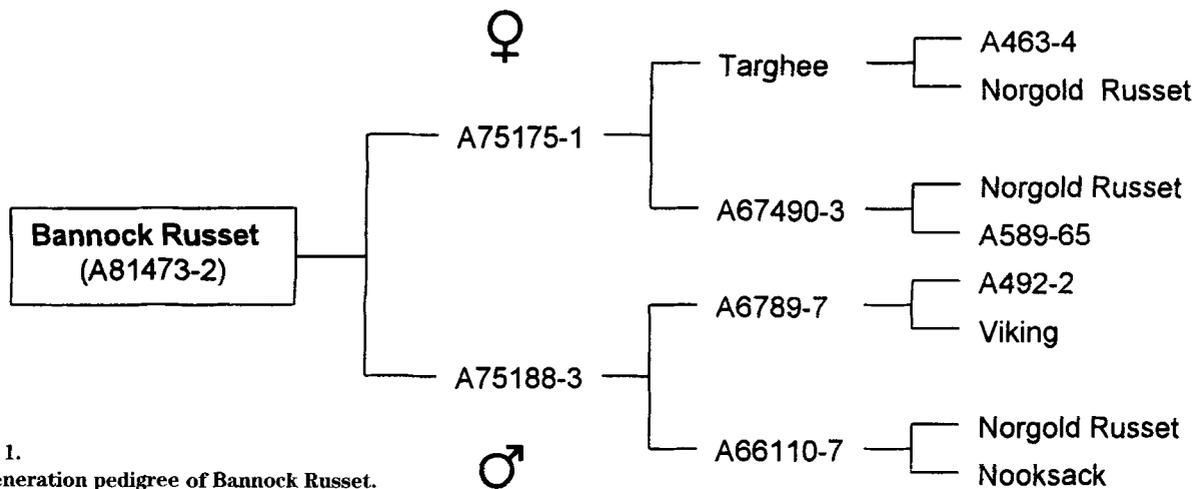


FIGURE 1.
Three-generation pedigree of Bannock Russet.

reducir significativamente los costos de producción de los agricultores.

INTRODUCTION

Bannock Russet was first grown and selected in the field at Aberdeen, ID in 1984, and given the pedigree number A81473-2. It originated in 1981 from a cross between russeted selections A75175-1 and A75188-3. Potato cultivars in the pedigree of Bannock Russet (Figure 1) include Norgold Russet (Johansen 1965), Targhee (Pavek et al. 1973), Nooksack (Hoyman and Holland 1974), and the red-skinned Viking (Johansen et al. 1963).

Bannock Russet was evaluated as a 12-hill selection in 1985, and from 1986 to 1990 in yield trials in Idaho. Bannock Russet was entered in Tri-State trials in Idaho, Oregon, and Washington from 1989 to 1990, and subsequently advanced to the Western Regional Trials where it was evaluated at sites in California, Colorado, Idaho, New Mexico, Oregon, Texas, and Washington from 1991 to 1993. Seed increases and commercial trials of Bannock Russet were conducted in Idaho, Oregon, and Washington.

On the basis of research and commercial trials, the decision was made to release A81473-2 as Bannock Russet. The name, Bannock, is widely used in Idaho geographical descriptions and is derived from the Bannock tribe that is present in southern Idaho. Release documents were completed on June 28, 1999.

DESCRIPTION

Plants (Figure 2): *Growth habit*: Large, upright, with a semi-closed canopy and late vine maturity (approximately 2-3

wk later than Russet Burbank). *Stems*: green, lacking anthocyanin pigmentation, with weakly expressed, straight-edged stem wings (~1-2 mm wide). *Leaves*: medium green, moderately pubescent with a medium-open silhouette; no pigmentation is present in the petiole. *Terminal leaflets*: medium ovate, with an acuminate tip, obtuse base, and slightly wavy margins; average length of 71 mm, width of 50 mm (100 leaves). *Primary leaflets*: range of 3-5 pairs, with an average of 4.0; medium ovate with a cuspidate tip and cordate base. *Secondary leaflets*: range of 0-4 pairs, average of 2.4. *Tertiary leaflets*: range of 0-6 pairs, average of 1.0. *Stipules*: medium-large, clasping.

Flowers (Figure 2): range of 1-4 inflorescences per plant, average of 2.4, with a range of 7-25 buds/inflorescence; pigmentation of calyx is absent. *Corolla*: white, pentagonal shape, with a mean width of 33.4 mm. *Anthers*: yellow-orange (Value 14B, Royal Horticultural Society Color Chart, London, England), broad cone-shaped, with no pollen shed. *Stigma*: capitate. *Berries*: typically none in the field, but successful berry set is possible in the greenhouse when used as a female parent in hybridizations.

Tubers (Figure 2): oblong to long, similar width to that of Russet Burbank, but an average of 12 mm shorter than Russet Burbank (100 tubers 200-250 g); mean length: 106 mm (range 77-139), mean width: 66 mm (range of 56-81), mean thickness: 55 (range 45-77). *Set*: low (<8/hill). *Skin*: tan to brown color; heavily russeted. *Eyes*: shallow to intermediate depth, with a mean number of 12 eyes/tuber that are concentrated near the apical end; eyebrows are not prominent. *Flesh*: white. *Dormancy*: approximately 135 days at a storage temperature of 7.3 C as compared to Russet Burbank at 155 (Dr. Gale Kleinkopf, University of Idaho-Kimberly, pers comm). Dormancy break based

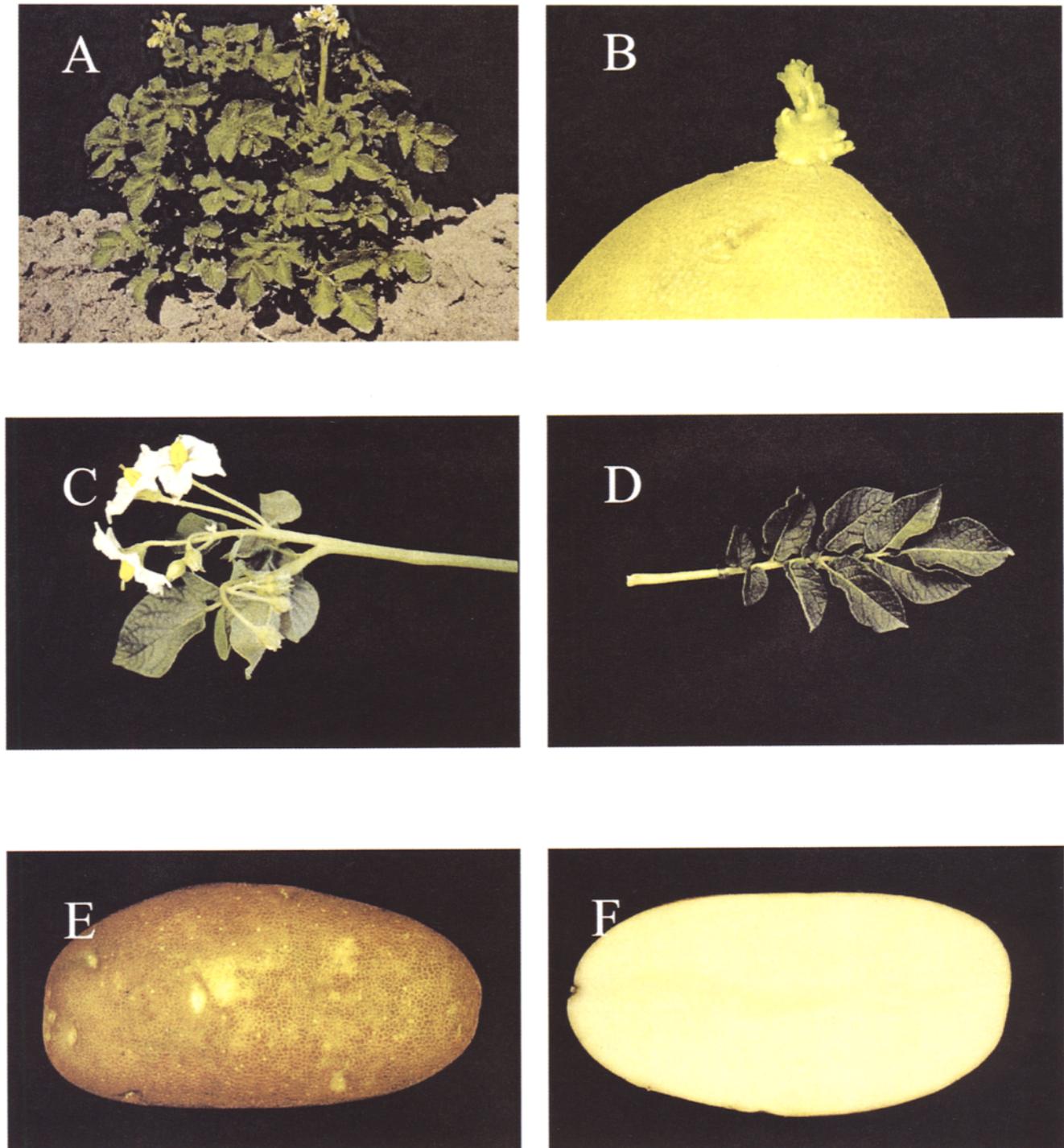


FIGURE 2. Bannock Russet (A) plant, (B) light sprout, (C) flower, (D) leaf, (E) tuber, and (F) flesh.

on 50% of tubers showing one or more eyes with growth greater than peeping but < 5mm in length.

Light Sprouts (Figure 2): broad, green, no pigmentation or pubescence.

TABLE 1—Average total yield, U.S. No. 1 yield, tuber size distribution, specific gravity, and french fry color of Bannock Russet and Russet Burbank from 38 full-season yield trials in southern Idaho locations.¹

Cultivar	Yield (mt/ha)			Specific Gravity ²	Tuber size distribution ³				Fry color ⁴		
	Total	U.S. No. 1	% No. 1		>341 g	170–341 g	114–170 g	<114 g	Cull	4.4 C	7.3 C
Bannock Russet	47.9	42.0	88	1.084	36%	39%	12%	8%	5%	3.1	1.7
Russet Burbank	45.1	29.0	64	1.080	13%	34%	15%	18%	20%	3.7	1.9

¹Trials were conducted from 1986 to 2000 and included the following ID locations with their respective number of trials: Aberdeen (9), Kimberly (7), Parma (8), Raft River (2), Rexburg (6), and Shelley (6).

²Specific gravity was determined using the weight-in-air, weight-in-water method.

³Total yield was graded, and tubers separated by size and defects. Size distribution is reported as percent of total yield.

⁴French fry scores rated using USDA standards, with 0=light and 4=dark. A rating of <3.0 is an acceptable score. Tubers were evaluated following 3-6 months storage at 4.4 or 7.3 C.

CHARACTERISTICS

Agronomic Performance

Bannock Russet produces total yields that are very similar to those of Russet Burbank in full-season trials (135-150 days after planting) in southern Idaho (Table 1). However, the average U.S. No. 1 yield of Bannock Russet was 45% greater than that of Russet Burbank

(Table 1). Bannock Russet and Russet Burbank were similar in their percentage of yield in the 114-341 g categories, but Bannock had 23% more of its total yield in the oversize (>341 g) class than did Russet Burbank. Smaller tubers of Bannock Russet (<170 g) tend to have less length than those of Russet Burbank.

Bannock Russet was also evaluated in the 1991-1993 Western Regional Potato Variety Trials (Table 2). In those full-season trials, Bannock Russet's total yield and specific gravity were found to be very similar to those of Russet Burbank across locations. However, the percentage of total yield that met U.S. No. 1 standards averaged 9% higher for Bannock Russet when compared with Russet Burbank (Table 2). Merit scores for processing and fresh market were consistently higher for Bannock Russet than for Russet Burbank (Table 2), indicating its strength as a dual-purpose cultivar for processing and fresh market.

TABLE 2—Total yield, percentage U.S. No. 1 yield, specific gravity, and merit scores of Bannock Russet and Russet Burbank in full-season trials in the 1991-1993 Western Regional Potato Variety Trials.¹

	CA	CO	ID			OR			WA	Mean
			1	2	NM	1	2	3		
<i>Total Yield (mt/ha)</i>										
Bannock Russet	63.6	50.5	52.1	58.9	44.2	82.7	55.9	61.6	74.1	60.4
Russet Burbank	72.9	52.5	53.3	57.9	46.9	88.4	53.0	61.2	86.4	63.6
<i>% U.S. No. 1</i>										
Bannock Russet	88	86	89	87	90	88	91	88	85	88
Russet Burbank	80	72	62	58	89	67	74	72	68	79
<i>Specific Gravity</i>										
Bannock Russet	1.081	1.089	1.085	1.087	1.082	1.079	1.080	1.092	1.079	1.084
Russet Burbank	1.082	1.085	1.085	1.086	1.083	1.081	1.084	1.078	1.082	1.083
<i>Merit-Process²</i>										
Bannock Russet	n.a.	4.3	4.0	n.a.	2.3	n.a.	n.a.	n.a.	n.a.	3.5
Russet Burbank	n.a.	3.0	3.3	n.a.	1.7	n.a.	n.a.	n.a.	n.a.	2.7
<i>Merit-Fresh²</i>										
Bannock Russet	3.3	3.3	3.7	n.a.	2.7	n.a.	n.a.	n.a.	n.a.	3.3
Russet Burbank	3.0	2.3	3.0	n.a.	1.7	n.a.	n.a.	n.a.	n.a.	2.5

¹Trial locations were Tulelake (CA), San Luis Valley (CO), Aberdeen (ID-1), Kimberly (ID-2), Farmington (NM), Hermiston (OR-1), Klamath Falls (OR-2), Malheur (OR-3), and Othello (WA).

²Collaborators gave two individual merit scores for processing and fresh-market potential on a 1 (poor) to 5 (very good) scale. These ratings reflect evaluators' analyses of an entry's performance at their respective site with criteria being tuber type and sizing, yield, specific gravity, and internal and external defects. ID merit scores were submitted as the mean of scores from the Aberdeen and Kimberly locations.

Quality Characteristics and Usage

The specific gravities of tubers of Bannock Russet are consistently higher

TABLE 3—*Evaluation of internal and external defects for Bannock Russet and Russet Burbank in southern Idaho.*

Cultivar	Growth cracks ^{1,4}	Second growth ^{1,4}	Shatter bruise ^{1,5}	Hollow heart ^{2,6}	Blackspot bruise ^{3,7}
Bannock Russet	4.6	4.9	3.4	7.2	2.4
Russet Burbank	4.2	3.4	3.5	6.1	2.7

¹Rated using a 1-5 scale with 1=severe and 5=none observed.

²Rated as the percentage of tubers >341 g with hollow heart.

³Rated using a 1-5 scale with 1=none observed and 5 = severe

⁴Average of 23 trials conducted in southern Idaho.

⁵Average of 13 trials conducted in southern Idaho

⁶Average of 38 trials conducted in southern Idaho.

⁷Average of 31 trials conducted in southern Idaho.

than Russet Burbank in Idaho (Table 1), and similar to Russet Burbank at other western sites (Table 2). French fry color also was found to be very similar to that of Russet Burbank after extended storage at 4.4 or 7.3 C (Table 1). However, fry defects such as sugar ends and mottling are generally lower in Bannock Russet. In areas prone to the expression of net necrosis in tubers, Bannock Russet's resistance can be of benefit to both growers and processors. These characteristics, in conjunction with Bannock Russet's relatively long dormancy, make it suitable for processing purposes.

Bannock Russet has shown little susceptibility to internal or external defects (Table 3). In comparisons with Russet Burbank, Bannock Russet displays a reduced incidence of second growth, but a slightly higher incidence of hollow heart (Table 3). Evaluation of tubers a month after harvest for shatter bruise, did

not show a significant difference between Bannock Russet and Russet Burbank (Table 3). However, commercial evaluations of Bannock Russet have identified a greater susceptibility to shatter bruise at harvest than has been observed for Russet Burbank. Production and handling protocols for minimizing shatter bruise in Bannock Russet are detailed in the management section of this manuscript.

Taste panel evaluations of Bannock Russet and Russet Burbank gave very similar sensory ratings (Table 4). The only sensory characteristic that appeared to differ between the two potato cultivars was pre-storage texture ratings; Bannock Russet scored 0.4 units lower than Russet Burbank in this category. Following storage, texture ratings between the two cultivars were nearly identical (Table 4). Acceptable sensory characteristics and attractive tuber type make Bannock Russet suitable for fresh market.

Disease Response

Bannock Russet is notable for having multiple resistances to potato virus Y (PVY), common scab (*Streptomyces scabies*), Verticillium wilt (*Verticillium dahliae*), early blight (*Alternaria solani*) of tubers, and the expression of tuber net necrosis in potato leafroll virus (PLRV) infected plants (Table 5). It also displays moderate resistance to foliar early blight and *Erwinia* soft rot. Bannock Russet is susceptible to foliar and tuber infection by late blight (*Phytophthora infestans*). In comparisons with Russet Burbank, Bannock Russet has a similar foliar susceptibility to late blight, while tuber blight susceptibility is slightly greater. Bannock Russet is susceptible to corky ringspot (tuber symptom of infection by tobacco rattle virus), PLRV, PVX, Fusarium dry rot (*Fusarium solani*), and Columbia root-knot nematode (*Meloidogyne chitwoodi*).

Assignment of disease resistance/susceptibility ratings were based on a minimum of two years of replicated field evaluations (with the exception of a one-year evaluation for corky ringspot). Verticillium wilt, common scab, and early blight evaluations were conducted at Aberdeen, Idaho, using naturally occurring inoculum. *Verticillium dahliae* is the fungal type present at Aberdeen. Protocols for assessing germplasm response to Verticillium wilt were previously described by Corsini *et al.* (1988).

TABLE 4—*Sensory evaluations of baked potatoes of Bannock Russet and Russet Burbank.*¹

Cultivar	Pre-storage ²				Post-storage ³			
	Color	Texture	Flavor	Overall appeal	Color	Texture	Flavor	Overall appeal
Bannock Russet	6.5	5.9	5.9	6.0	6.7	6.1	6.1	6.2
Russet Burbank	6.4	6.3	5.9	6.1	6.7	6.2	6.1	6.2

¹The pre-storage and post-harvest blind sensory evaluations were conducted using 10-12 trained panelists. The values given represent the mean of three sessions conducted over a 3-year period (1 session/year). Tubers were rated for color, texture, flavor, and overall appeal using a scale with 1=very poor quality and 9=exceptional quality.

²Pre-storage evaluations were conducted approximately 1 month after harvest, prior to the time that the final holding temperature of 4.4 C was reached.

³Post-storage evaluations were conducted following 5-6 months storage at 4.4 C.

TABLE 5—Disease responses of Bannock Russet and Russet Burbank.¹

Cultivar	Vert. wilt	Common scab	Early Blight		Late Blight		Viruses ²			Symptoms of virus infection		Storage diseases	
			Foliar	Tuber	Foliar	Tuber	PLRV	PVY	PVX	Net necrosis	Corky ringspot	Erwinia soft rot	Fus. dry rot
Bannock Russet	VR	VR	MR	R	S	S	S	R	S	VR	S	MR	S
Russet Burbank	S	R	S	MR	S	S	S	S	S	S	S	S	S

¹Ratings were based on a minimum of two years of controlled field evaluations (with the exception of a one-year evaluation for corky ringspot). Ratings are defined as very resistant (VR), resistant (R), moderately resistant (MR), susceptible (S), and very susceptible (VS).

²Virus reaction was based on seed-born infection as determined by ELISA, following field evaluation with inter-planted virus-infected potato plants and a high density of green peach aphid.

Common scab and early blight evaluations consisted of three replicates in a randomized complete block (RCB) design with analyzed data used for assigning disease reactions. Late blight field evaluations with naturally occurring inoculum were conducted at Mount Vernon, Washington, using protocols previously described by Inglis et al. (1996). Evaluations of PLRV, PVY, and PVX resistances were conducted at Kimberly, Idaho, using virus-infected spreader rows; the protocol used was described by Corsini et al. (1994). The corky ringspot evaluation consisted of a 10-replicate RCB design in the Egin Bench region of Idaho (Steve Love, unpublished data). Storage disease assessments were as described by Corsini and Pavek (1986). Columbia root-knot nematode ratings were provided by Dr. Chuck Brown and Dr. Ken Rykbost in replicated trials conducted in the Columbia Basin region of Washington state and the Klamath Basin region of Oregon, respectively (unpublished data).

Biochemical and Nutritional Characteristics

Tubers of Bannock Russet and Russet Burbank grown at Aberdeen, Idaho, were analyzed over a three-year period to assess biochemical and nutritional components (Table 6). Ban-

nock Russet was higher in dry matter content, protein, and vitamin C than Russet Burbank. Sucrose levels were higher in Bannock Russet than in Russet Burbank, but reducing sugar content was lower. Total glycoalkaloids for Bannock were very low at 1.2 mg/100g tuber fresh weight.

Management

Studies on management practices optimal for production of Bannock Russet have been conducted primarily in southeastern Idaho. However, the results of these studies also provide growers in other production regions with a foundation for the development of management guidelines specific for their region.

Seed spacing trials (Love et al. in press) indicate that optimal spacing of Bannock Russet seedpieces on 91-cm rows are (1) seed production—15 to 18 cm, (2) fresh market—20 to 25 cm, and (3) processing—23 to 28 cm.

Based upon data obtained from 3 years of nitrogen management studies, total nitrogen recommendations for Bannock Russet are approximately 40% less than nitrogen recommendations for Russet Burbank (Love et al. in press). In southeastern Idaho where potential potato yields are 33.6 – 44.8 mt/ha (300-400 cwt/A), it is recommended that 118 – 163 kg N/ha (105 to 145 lbs N/acre) be applied. In shorter season seed-growing regions, all nitrogen can be applied as pre-plant. In commercial production areas of Idaho, nitrogen application may be split into a pre-plant application and a second application that should be incorporated no later than July 31. Nitrogen applied after the July deadline will delay maturity of an already late-maturing cultivar, creating difficulties with vinekill and tuber maturation. Problems with vinekill

TABLE 6—Biochemical analyses of Bannock Russet and Russet Burbank tubers sampled from the 1991-1993 Western Regional Potato Variety Trials at Aberdeen, ID.¹

Cultivar	Dry matter (%)	Sucrose (% FWB ¹)	Reducing sugars		Vitamin C (mg/100g FWB ¹)	Total glycoalkaloids (mg/100g FWB ¹)
			(% FWB ¹)	Protein (% DWB ¹)		
Bannock Russet	23.4	0.27	0.14	5.8	21.6	1.2
Russet Burbank	22.5	0.18	0.19	4.5	18.8	8.3

¹FWB = Fresh Weight Basis; DWB = Dry Weight Basis

and tuber maturation also may be experienced if Bannock Russet is planted the year immediately following alfalfa. Continued mineralization of nitrogen late into the summer from alfalfa residue may be sufficient to delay Bannock Russet's maturation. Recommended petiole nitrate concentrations are as follows: 20-22,000 ppm until tuberization, 18-20,000 during tuberization, 11-16,000 during early bulking, 5-10,000 during late bulking, and 2-6,000 during senescence (Love *et al.* in press).

No detailed research has been conducted regarding the phosphorus, potassium, or micronutrient requirements of Bannock Russet. For these nutrients, it is recommended that growers follow guidelines developed in their area for Russet Burbank.

No sensitivity to metribuzin, when applied at labeled rates, has been observed in Bannock Russet. No injury has been observed on Bannock Russet with the use of other herbicides currently registered for use on potatoes. The critical period for weed control in Bannock Russet is prior to row closure; after that period, Bannock Russet produces a vine that can compete with most mid- to late-season weeds.

Bannock Russet's low tuber set and tendency for large tuber size requires careful monitoring. When the optimal tuber size is reached, vines should be killed. Allow adequate time for vinekill prior to harvest (generally 21 days) to allow for tuber maturation and skin set.

Minimization of shatter bruise in Bannock Russet is best achieved by allowing soil drying (55% available soil moisture) after vinekill, followed by irrigation 1-2 days prior to harvest. Harvest also should be avoided if tuber pulp temperature is <10 C. Optimization of harvest equipment to eliminate bruise points also is recommended.

Fusarium dry rot can be a problem with Bannock Russet if tubers are immature or damaged. The natural tuber dormancy of Bannock Russet is approximately 20 days shorter than for Russet Burbank at a storage temperature of 7.3 C. Potatoes to be held longer than 3 months at 7.3 C will require an application of a chemical sprout inhibitor.

SEED AVAILABILITY

In 2001, seed was available from potato seed growers in Idaho, Montana, and Colorado. Small amounts of seed, for research purposes, can be obtained by contacting the corresponding author. The University of Idaho, acting on behalf of the Tri-State Potato Breeding Program, has filed an application for Plant Variety Protection for Bannock Russet.

ACKNOWLEDGMENTS

The authors thank Margaret Bain, Scott Cordon, Darren Hall, Edith Isaak, Feliks Pazdan, Tom Salaiz, Brian Schneider, Penny Tubbs, and Andrea Wilson for their contributions to the potato cultivar development efforts at Aberdeen, Idaho. We also thank our industry cooperators, our collaborators in the Western Regional Potato Variety Trials, and the Idaho, Washington, and Oregon potato commissions. Development of Bannock Russet was partly funded by the USDA/CSREES Special Potato Program Grant.

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